Midwest Engineer

SERVING THE ENGINEERING PROFESSION

WESTERN SOCIETY OF ENGINEERS FOUNDED 1869

THE NATIONAL SCIENCE FOUNDATION—PAGE THREE

WSE MEETINGS—PAGE TWO

Vol. 5 DECEMBER, 1952 No. 7

MIDWEST ENGINEER
Published Monthly
BY
THE WESTERN
SOCIETY OF ENGINEERS
AT
2207 DODGE AVENUE
EVANSTON, ILLINOIS

J. EARL HARRINGTON
Editor and Business Manager

HAROLD K. EATON
Managing Editor

GENERAL AND EDITORIAL OFFICES
HEADQUARTERS OF
WESTERN SOCIETY OF ENGINEERS
84 E. RANDOLPH STREET
CHICAGO 1, ILLINOIS
TELEPHONE: RA NDOLPH 6-1736

The Society does not assume responsibility for statements and opinions in articles, papers and discussions appearing herein. All material must be submitted on or before the 10th of the month prior to date of publication.

Single Copy ....$ .50
Annual subscription........ 4.00
Foreign subscription....... 6.00

Entered as second-class matter September 23, 1948 at the post office at Evanston, Illinois under the Act of March 3, 1879.

Midwest Engineer

A Publication of the
WESTERN SOCIETY OF ENGINEERS
Serving the Engineering Profession

DECEMBER, 1952 — Vol. 5, No. 7

CONTENTS

Cover Story

Christmas, U.S.A., 1952. Our cover picture shows what most children and many grown-ups, too, are dreaming of: a white Christmas. The snowy scene was taken along Sheridan road near Milburn street in Evanston, Illinois.

—Acme Photo

this month at WSE

COMING EVENTS OF INTEREST TO ALL MEMBERS

December 25, Holiday

A very merry Christmas to all members of WSE, to their families, and to their friends.

December 29, No Meeting

Due to the holiday season.

January 1, Holiday

And to them also, the very best of everything to make their lives in the coming year more full, and the happiest ever.

January 5, Traffic Engineering and City Planning Section

Speakers: A panel composed of the following: Joseph K. McLaughlin, Director of the Department of Aeronautics, State of Illinois; Dr. H. C. Hardy, Armour Research Foundation, Illinois Institute of Technology; Edward Flickinger, Chief Land Planning Consultant, Chicago Regional Office, Federal Housing Administration; and George W. Vest, Regional Administrator, Civil Aeronautics Administration. Wayne Thomis, Aviation Editor of the Chicago Tribune, will act as moderator.

Subject: "The Airport and its Neighbors, or The Relation of the Airport to Community Planning."

January 7, Noon Luncheon Meeting

Speaker: Albert Alfredson, Illinois Bell Telephone Company, Communications Maintenance Department.

Subject: "Painting an Avocation for the Engineer."

Mr. Alfredson, talented and successful artist in his spare time, will demonstrate his technique and explain why painting is an excellent hobby for the engineer, or any other man or woman in business. Come and learn how to get started in painting as a pastime. Mr. Alfredson is a member of the Palette and Chisel Academy of Fine Arts, an organization of businessmen artists; the Northwest Art League; the North Shore Art Guild; and the All Illinois Society of Arts.

January 12, General Meeting

Speakers: Mr. and Mrs. Donald J. Simpson of Evanston, Illinois.

Subject: "On Top of the Alps."

This program, replete with color slides of mountain climbing in Canada and Switzerland, will be presented by two avid mountain climbers. The Simpsons, Northwestern University graduates, will bring along complete equipment used on mountain climbing expeditions, everything, in fact, except pack mule, guide, and mountain! The use of the equipment will be demonstrated.

January 19, Bridge and Structural Section

Speaker: J. M. Trissal, Assistant Chief Engineer, Illinois Central Railroad.

Subject: "Air Rights over the Illinois Central involved in the Construction of the Prudential Building."

The development of air rights over a busy railroad yard and passenger station involves many legal, engineering, and operating problems. The historical background of the area, as well as the manner in which the problems were solved, will be presented.

January 26, General Meeting

Speaker: E. E. Benzenberg, Senior Coordinator, Hull Division, Gibbs and Cox, Inc.

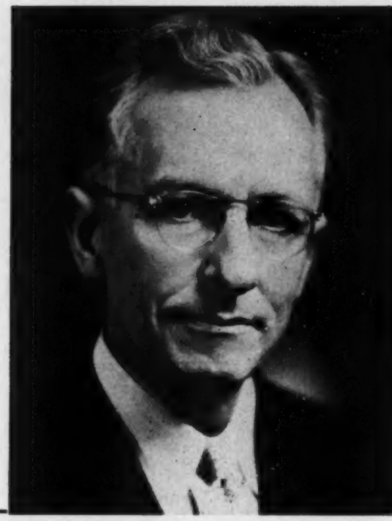
Subject: "S. S. United States."

Mr. Benzenberg will give a description of the $70,000,000 superliner of the United States Lines. He is a member of the organization responsible for the design of the "United States," the ship which holds the transatlantic speed record.

Movies of the ship at sea during tests will be shown. Featured will be the ship's fire-resisting hull construction.

A model of the "United States" will be on display. The model is being made available by the United States Lines.

The National Science Foundation



By Dr. Paul E. Klopsteg

It is one of the pleasant experiences in human associations to have a reunion with old friends and acquaintances. For me this is one of those occasions. I am grateful to the Western Society of Engineers and its President for providing the opportunity for such a reunion. I appreciate also the opportunity of speaking to this distinguished and important group on matters of vital concern to science and engineering, and to all who have an interest in research and education in the sciences, and the bearing of science upon the nation's welfare.

In addressing myself to the problems and functions of the National Science Foundation, I am in the favorable position of an observer who has had opportunity for a year of seeing them at close range and has, I hope, begun to understand some of their implications.

Permit me, if you will, to make a brief digression from the main theme of this discussion. I want to assert my deep-seated aversion to anything bureaucratic. I always have been, and hope that I shall continue to be, allergic to the words and expressions for which great fondness is manifested by persons who, by using them, run the risk of identifying themselves as bureaucrats. I have yet to see the instance when ordinary English could not serve—indeed when it could not better serve—to convey intended ideas. Surely it is possible and desirable to avoid the use of such words and expressions as *to implement, guidelines, framework of reference, phasing out, dis-establishment, impingement, integrated units, to position, to structure,* and similar components of gobbledegook. I trust that I shall never find myself "setting my ducks in a row along guidelines within a framework of reference." If I do, I shall know that it's time to leave Washington and come home. Having disposed of this pet peeve, I shall get on with the pleasant business which has brought me here.

It may be taken for granted that all of you are somewhat informed about the National Science Foundation. It would be unrealistic to assume that many of you have more than passing knowledge about its organization, program and policies.

Government support of science is not new. Our state universities have for many years included agricultural and engineering experiment stations, devoted principally to experimental work of interest to farmers and manufacturers in the state; but basic research in the natural sciences has also been an important part of the activity of an academic faculty in state-supported as well as privately-endowed institutions. At the national level, we have had instances of support for studies having practical value to the country generally, in areas where for good and obvious reasons private funds are not employed. The Department of Agriculture, the Bureau of Mines, the Geological Survey, the Bureau of Standards, and the Fish and Wildlife Service are examples of agencies which have carried on applied research, and, to a small extent, basic research, for many years. There will be no disagreement with the principle of spending public money for such developments.

The second world war found us lacking in all sorts of devices and procedures required by the armed forces, and reflected our inactivity in research and development in military matters during the preceding two decades, notwithstanding the demonstrations of their importance that any thoughtful and foresighted person could have perceived in studying the first world war. It took the genius of men like Bush, Compton and Conant to realize during the "phony" war in Europe that if the war became genuine and we were drawn into it—as inevitably we would be—we had better be doing something about it. Through Dr. Bush, the President was persuaded of the importance of this conclusion, and established the National Defense Research Committee in June of 1940. A year later, the Office of Scientific Research and Development was created, comprising the National Defense Research Committee, the Committee on Medical Research and later the Office of Field Service.

It is important to recognize that the

(Continued on Page 4)

Dr. Klopsteg, formerly Director of Research, Northwestern Technological Institute, and Chairman of the Board, Argonne National Laboratory, is now Assistant Director of the National Science Foundation. He presented this talk before the Western Society of Engineers at the Society's annual Fall Dinner on November 17, 1952.

(Continued from Page 3)

impressive and outstanding results of the activities initiated by the Office of Scientific Research and Development came about through intensive efforts in development, not basic research. The Office of Scientific Research and Development might perhaps more properly have been called Office of Scientific Development. The work was done through contracts with universities, colleges and private institutions. For the most part, these were established on a "no profit, no loss" basis. During the same period, the Manhattan Engineer District was created, to develop a nuclear weapon. A vast amount of basic research and development in this area led to the results with which we are familiar.

Towards the close of the war, and immediately thereafter, facts about the great developments that had been made by scientists and engineers became a favorite subject for journalists. An impression was created in the mind of the layman that science is wonderful, and that the scientists' efforts had made military success possible and had shortened the war. It is a moot question whether the lay public gained any appreciation of the methods of science or of the fact that the remarkable developments of the war years would have been impossible had not the scientists in their university and college laboratories, through the nineteenth and twentieth centuries, laid the foundations through patient, persistent study, without thought of practical ends. It is doubtful also that there was any appreciation except among the scientists themselves of the fact that most of the fundamental discoveries had been made not by Americans but preponderantly by Europeans. Inventiveness and the ability to apply knowledge to specific problems, and great genius in mass production for war or peace of the new things created through applied science and engineering, have been the outstanding characteristics of American enterprise.

It is perhaps obvious that our store of scientific knowledge, unlike a supply of expendable commodities, cannot be "used up." Nevertheless, the number of applications that can be made of a scientific principle to problems in a limited area is limited, and one may expect diminishing returns from efforts to apply the principle in more than a finite, fairly small number of ways. This fact was recognized by Dr. Bush as the war was drawing to a close. Many of you know him, and you know that when he sees a problem, he does something about it. It led to the request by the President, in 1944, that Dr. Bush provide the answers to four questions relating to the future of science in America. Bush appointed committees of great ability to study the questions and advise him, so that he might reply to them, backed by the weight and authority of the committees.

Dr. Bush transmitted his reply to the President in July, 1945, in a blue-covered volume that has become notable in American science. Its title is *Science, the Endless Frontier*. The recommendations there made recognized the imperative need that the scientists in our academic institutions be provided with the time and facilities to engage in basic research, research of their own choosing, to discover new facts and principles of nature. They recognized also that although academic research is acknowledged in many institutions to be an activity of a scholar equal in importance to his teaching, the resources of universities and colleges did not enable these institutions to support adequately the research of their faculty. This led to the sound principle that basic research is of the utmost importance to the nation as a whole—important to its survival through adequate defense, and important to its progress in an economy of peace. On this principle public support of basic research is clearly warranted. There is, in fact, no other source of funds sufficient for the needs of basic research in its modern concept.

The recommendations of the Bush report were, in effect, the first comprehensive and well-formulated recommendations relative to a national policy in research and education in the sciences. Note that it did not establish, but only recommended, policy. *Establishment* of policy in this area was initiated by the introduction of federal legislation, intended to give effect to the recommendations. In the meantime, it appeared that the legislative effort might be a protracted one. At the suggestion of a scientific group attached to the Office of the Coordinator of Research and Development, the Secretary of the Navy established the Office of Research and Invention in 1945. Among other functions, it supplied financial assistance needed by research scholars in the colleges and universities. In 1945, the Office of Naval Research by statute became the successor agency, and every research scientist knows the distinguished service this office has rendered. Eventually, legislative activity in the Congress resulted in the National Science Foundation Act which became law in May, 1950. Thus, the Foundation came into existence, with the inevitable complexities in organization and statements of function that arise out of the confusion of a long legislative operation.

Notwithstanding these complexities, the very fact of establishment of the National Science Foundation was the first major step in setting national policy with respect to the place of federal government in research. The enumeration of "Functions of the Foundation" in Sec. 3 of the Act is a statement of certain components of national policy for which the Foundation under the act is responsible. The first of these functions reads: "to develop and encourage the pursuit of a national policy for the promotion of basic research and education in the sciences."

The statement quoted is of itself a fundamental doctrine of national policy. Moreover, it constitutes an injunction not merely to carry out the other functions recited in the act, but also to move into unspecified areas to examine into any matters bearing on national policy and, insofar as it may be feasible, to produce a blueprint and specifications for soundly building a structure within which such objectives as are set forth in the Bush report may be achieved. New objectives that have acquired importance during the intervening years may appear and should be included.

An excellent beginning was made in the Bush Report. It could obviously be only a beginning. In the passage of time some objectives are reached, others require modification because of economic, political or social changes; some disappear, others come into view. The situation is one of continuous and continuing change. We need to remain alert and aware of the situation, and to have before us currently a clear picture in which we may see both what is and what should be "national policy for the promotion of basic research and education in the sciences."

(Continued on Page 12)

Can Engineers Man A Company

By E. G. Bailey

My answer to the question, "Can engineering graduates man a company?" is yes, because they are now doing it very creditably in many cases. The important point is: How can each one of us study the many cases at hand and draw some helpful conclusions regarding college curricula, selection of graduates, training, and promotion of engineers for the best interests of our industrial economy?

The success of a company is usually measured by its usefulness to mankind, its rate of growth, and its earnings. A good record in these respects is usually the result of team work on the part of management to evaluate properly the needs in a given field of products or services, and to accomplish results through invention, development, production methods, sales, services, and finance.

The August 30 issue of *Business Week* gives some interesting data regarding ten companies which now show a marked contrast from the average of industry generally over the same period. Eight of these ten companies show an average increase in invested capital of 42 per cent per year from 1929 to 1951, while the invested capital of industry generally increased at the rate of 2.8 per cent per year over the same period.

The net profits of the eight companies averaged 11.2 per cent of invested capital in 1929 and 9.6 per cent of the increased capital of 1951. Some of these data are given in the accompanying table. It would be interesting to study the management policies of these companies with respect to our topic.

Statistics alone are sometimes misleading. During a depression the earnings and growth may be poor even though the management is good. Contrariwise, during an inflationary "easy prosperity" like the present, very poor management of a company may not be evident, even to the stockholder.

Now, let us review some average statistical data from the Engineers' Joint Council survey of 1946 on "Employer Practice Regarding Engineering Graduates."[1] In this summary 125 companies, with a total of 2,020,000 employees, reported 38,000 engineers employed. This is 1.8 per cent of the total number of employees, or one engineer for each 55 employees. In some industries the engineers were 6 per cent of all employees and in others as low as 0.3 per cent. In some groups the engineer executives comprised 50 per cent of all executives of the same rank, and in others as low as 13 per cent with an average of 28 per cent. The anticipated increased need of engineers was 6 per cent per year of the engineers then employed, or one engineer for each 1000 employees.

From this survey a median of the 14 companies within the machinery group has been selected to represent a typically average industrial company. This we shall call "X-Machine Company," employing a total of 7,000 people and having a gross sales of about $80,000,000 per year. This is a fairly representative figure of about $12,000 output per employee.

This company employs 133 engineers, 28 of whom, which is 21 per cent, are in executive and top management positions. The total number of executives and upper managers is 64, of whom 44 per cent are engineers.

This industry group said they needed 8 per cent additonal engineers per year, or, for "X-Machine Company," 11 engineering graduates each year, or 1½ engineers per 1000 employees.

In my opinion, a company in this kind of engineering business should have about 80 per cent of its executives with engineering training. The reason for this is that an engineering education is eminently helpful as a background for fact-

(Continued on Page 15)

	INVESTED CAPITAL				*NET PROFITS*	
	Millions of Dollars		*Average Increase per year*		*Millions of Dollars*	
	1929	*1951*		*Per cent of 1929*	*1929*	*1951*
Abbott Laboratories	3.6	67.9	2.9	81.	0.6	10.4
Aluminum, Ltd.	50.2	443.5	17.8	36.	2.4	28.8
American Cyanamid	41.3	274.9	10.6	25.	2.3	34.8
B. F. Goodrich	162.6	239.8	3.5	2.	7.4	34.7
Humble Oil	216.4	916.5	31.9	15.	32.5	109.5
International Business Machines	33.7	318.3	12.9	38.	7.4	27.9
Minneapolis-Honeywell	4.9	80.0	3.4	70.	1.4	9.3
Minnesota Mining	4.8	106.6	4.6	96.	1.5	9.9
Monsanto Chemical	12.3	263.4	11.4	93.	1.1	23.5
Scott Paper	6.7	67.2	2.7	41.	0.9	10.9
TOTAL	536.5	2778.1	101.8	19.	57.5	299.7
Per cent of invested capital					10.7	10.8
Total with omission of B. F. Goodrich and Humble Oil	157.5	1621.8	66.4	42.2	17.6	155.5
Per cent of invested capital					11.2	9.6

DATA FROM *BUSINESS WEEK* August 30, 1952

[1]*Mechanical Engineering*, Jan. 1948.

Mr. Bailey is Vice-President of the Babcock and Wilcox Company, and is Chairman of the Board of the Bailey Meter Company, New York, N. Y. He is also Past President of A.S.M.E.

He developed a boiler meter in which the steam-flow and air-flow pens register on the same scale, giving an instantaneous indication of steam output and any excess combustion of air. Over 100 other patents have been registered in his name. Also, Mr. Bailey has received a number of academic honors and engineering awards.

Mr. Bailey delivered this talk at a joint meeting of E.C.P.D.-A.S.E.E. held at the Headquarters of the Western Society of Engineers on September 6, 1952.

THE NEXT STEP...

is progressing nicely.

The committee, however, needs your continued support in order that the expansion campaign may be successfully completed as soon as possible.

..IN THE DEVELOPMENT OF AN ENGINEERING AND SCIENCE HEADQUARTERS

WESTERN SOCIETY OF ENGINEERS FOUNDED 1869

Some Aspects of Jet Transport Work

By Elizabeth M. G. MacGill

The commercial exploitation of the aircraft gas turbine engine, and the introduction of turbine-powered airliners into scheduled service on the world's air routes is the challenge facing commercial aviation today. The immediate problems are not those of airframe design for the familiar airliner configuration can be continued up to speeds of about 650 m.p.h. without serious compressibility effects, and airline speeds will probably not exceed this figure for some time for reasons connected mainly with passenger comfort. The pressing problems are operating ones rising from the characteristics of the turbine engine. They include the large reductions in power and large increases in fuel consumption caused by small rises in atmospheric temperature, with their consequent loss of take-off power on the ground, loss of altitude in flight, and high operating expense; the high costs of engine overhaul and repair; the rates of fuel consumption which—except in the narrow design band of engine cruising conditions—are so excessive as to make today's conventional practices of taxiing, running-up, take-off, climb, stand-off and descent too expensive for commercial work. The last noted bears much more heavily on the turbo-jet than on the turbo-prop for the latter, while lacking the turbo-jet's speed potential, combines the advantages of the increased thrust of the turbine with the flexibility and efficiency of the reciprocating engine under part-load. The solution to these problems is being found in engine improvements, in measures to give extra aircraft lift when needed, and in practicable techniques and procedures in flight and in ground handling. The replacement of the present piston-engined fleets with turbine-engined types will bring with it a whole new set of operational concepts for it will be the first change in basic type of airline equipment since air transportation developed on a world scale in the 1930's. Now that British turbine-engined airliners are trickling into service here and there the general changeover cannot be delayed long. If the replacements come from the United Kingdom a new balance will be struck in the aviation world.

For over twenty years the United States has led in the commercial design and operating fields. Consequently today American operators carry more of the world's air tonnage than all other airline operators together, and American aircraft are in the majority on all the airlines with the exception of feeder lines. Around the world the very names of the American airliners — DC-6, Constellation, Stratocruiser, Convair—are as familiar as household words. Except in the instance of the latest recruit, the Convair, their prototypes flew in the early '40s, yet their production models are still being built, are being used to open up new routes, and will see service for years to come. All are "stretched" versions of prototypes that adhered to the twin-engined or four-engined design formulae developed in the early '30s. By that masterstroke American designers, exploiting the new Dutch and German all-metal monoplane techniques that were then making fabric, wood and the biplane obsolete, seized the design initiative, and, devising new operating techniques and design formulae (centered upon the reciprocating engine and the variable pitch propeller) established a supremacy that has remained with them up to the present time. Probably the DC-6B, Constellation and Convair are the ultimate expressions of these formulae for it is the nature of aircraft design to meet obsolescence at the height of success. Today the gas turbine engine offers wholesale increases in thrust at practicable fuel cost but, to be fully effective, it, like its predecessor the reciprocating engine, requires design and operating techniques tailored to its particular characteristics. Consequently opportunity for a repetition of the American coup has been opened up. This time, however, it is the United Kingdom that has seized the design initiative, and is making a spectacular bid for supremacy in the short range, medium range and long range aircraft categories.

Only the United Kingdom and the United States are continuing as general suppliers of large airliners for the development costs of these aircraft run into millions of dollars. The United Kingdom, needing American dollars, and with a whole market to gain and little to lose by forcing the changeover, has abandoned the reciprocating-engine type in these categories and, regardless of the uncertainty of the aeronautical world as to which type of powerplant—turbo-prop, turbo-jet, or compound diesel—carries the biggest commercial advantage, has put turbo-props and turbo-jets into production. The United States, on the other hand, has produced no commercial turbine-powered or compound diesel aircraft at all but has continued with the production of piston-engined machines, the very magnitude of American market success acting as a brake on enterprise. Strongly entrenched and with heavy vested interests in the piston-engined machines, the American operators and manufacturers had little to gain and much to lose by an early, perhaps a premature, changeover. So when aircraft were needed for the ever-expanding air routes they stuck to the reciprocating engine, introduced turbine compounding to get increased speed, and hedged their designs with compromises which would permit conversion to turbo-props later on, if expedient.

American experience with the twenty-year-old Douglas DC-group shows that, where the original design has plenty of "stretch" in it, operational economy can

(Continued on Page 8)

Elizabeth MacGill, Consulting Engineer, Toronto, Ontario, Canada, gave this talk before the Society of Women Engineers on September 5, 1952, at the Headquarters of the Western Society of Engineers.

(Continued from Page 7)

be improved over the years by a continuous process of increasing power, altitude, speed, fuel economy, range, payload and size. This practice is being applied with good effect to today's airliners. However, since big aircraft reduce the overhead per passenger and, with pressurized cabins, can be operated at higher altitudes to get higher speeds, and furthermore since higher speeds improve the power and economy of the gas turbine, especially of the turbo-jet, it is probable that this "stretching" process will be even more effective with the new types than with the piston-engined types. Consequently if by this practice the present British aircraft can bring the changes required by the various air routes they and their variants may establish themselves in service universally. The "stretching" of the *Comet* to suit the routes of British Overseas Airways Corporation and Canadian Pacific Airlines are steps in this direction. Furthermore, since only a relatively small number of commercial airliners are needed, fleets as great as 150 being uncommon, large scale production as the military manufacturer knows it does not apply here. The "break-even point" will remain relatively high, competition will be discouraged. Once established, the new aircraft will have an excellent chance of maintaining their position for a long time—just as the American machines did. By seizing the initiative the designers and operators of the United Kingdom have gained what amounts to a 3-to-5-year start on the rest of the world in the commercial exploitation of this new type. Economics, and the backlog of design and operating experience such a lead affords promises them a firm grip on the immediate and future market in these categories.

The opportunity which the United Kingdom used to such good advantage, we in North America passed over. Canadian engineers in particular must regret that Canada is not now hitting the market with a jet airliner, remembering that she pioneered that type on this continent. Three years ago, on August 6th, 1949—only ten days after the *Comet* made its record-breaking take-off—A. V. Roe Canada Limited of Malton, Ontario flew its prototype *Jetliner*, a four-engined, 40-passenger aircraft in the short range category, and the first commercial turbo-jet airplane designed and built in North America. No programme of intensive development followed, however. Last year all work on the *Jetliner* stopped in order to release plant capacity for and concentrate effort on military commitments. Last month press notices hinted that the *Jetliner* might be built under license in the United States, after some development and redesign to increase range had been carried out by an American Company. Probably not until the deHavilland Company of Canada builds British *Comets* will Canada produce turbine-engined airliners. Ironically, with all to gain and nothing to lose, Canada bowed out of the field she had pioneered, without attempting to exploit it commercially.

No prototype turbo-jet airliner has been designed and flown in the United States yet, nor has a purely turbo-prop airliner prototype come out of the shops there. The Superconstellation and the Martin 404 are convertible to turbo-props, and the Convair Turboliner, a standard Convair 240 equipped with Allison T-38 turbo-props, was flown on December 29, 1950 to check the feasibility of such conversions. Compromise designs usually pay in reduced performance for the convenience they afford, however using these aircraft will provide operating experience, and some development cost and time will have been saved although some will still be needed. The three or four years which are the minimum period for designing, developing and putting the first version of the prototype into limited production must be followed by one or two years spent in analyzing the flying qualities and operating performance characteristics, improving these by major re-design if necessary, perfecting the mechanisms of the many conditioning and controlling systems, preparing production drawings, and organizing procurement and production. A year for trial runs is usually needed by the airline operator. Indeed, a total of six years from the start of a design to the introduction of the production model into scheduled service is a very creditable achievement, for the times mentioned above are minima and allow for no major hitches. They assume that the design is a success from the start, and few are—the prototype seldom coming up to expectations on its initial trials. The design field is highly speculative and, as in bringing in a gusher or locating a goldstrike, more than one try is usually necessary. It was said of fighters during the Second World War that only one design in every 28 turned out to be a winner. Probably 3 or 4 casualties to each success is more appropriate to the conventional airliner, but new hazards attend new types, and the market always presents an extra hurdle for the commercial machine. The British aviation industry, in its diversification of effort—one turbo-jet, three turbo-

(Continued on Page 17)

An Atomic Power Plant

By Mario Palmieri

The coming change of the type of energy from which electric power is derived was forecast as far back as 1905 when Albert Einstein stated that the mass of a body is a measure of its energy content. Such a statement implied an equivalence of mass and energy, defined mathematically by the equation:

$$E=mc^2 \qquad (1)$$

the symbol c representing the velocity of light, assumed to be:

$$C=300.000\text{km/ sec.}$$

If such an equivalence exists in nature—and there is no longer any doubt that it does exist—it becomes apparent that we have at our disposal a tremendous reservoir of energy. This energy is ready to do our work if we not only know how to release it, but how to utilize it and how to distribute it.

That this reservoir of energy is of tremendous magnitude we can easily ascertain by calculating the amount of energy which is equivalent to the mass of one kilogram of matter.

It is customary, in such calculations, to refer all measurements to the fundamental units of the system c.g.s. (centimeter, gram, second).

Substituting actual values, equation (1) becomes:

$$\begin{aligned} E&=1000\ (3\text{x}10^{10})^2 \\ &=9\text{x}10^{23}\text{ergs} \\ &=9\text{x}10^{16}\text{ watt-sec.} \\ &=25\text{x}10^{9}\text{ Kilowatt-hour} \end{aligned}$$

which, as H. De Wolf Smyth states, is equal to the energy generated by the total electric power industry in 1939 in the United States, running for approximately two months.

Actually, we have not learned as yet how to convert into energy the total amount of mass, but, while this total conversion is yet to take place, we have succeeded in bringing about a partial conversion of the total mass. This is none the less spectacular and of far-reaching significance even though only partial.

This partial conversion releases the energy which had been converted into mass during the formation of the atom by changing this mass again into energy through the fission of the nucleus.

The understanding of this apparently so simple transformation requires a review of what we have learned so far about the constitution of matter.

We know first of all that matter is ultimately reducible to a definite number of elements, and that the word atom stands for the smallest indivisible particle of any element which can evince all the physical and chemical properties of that element.

We know that these ultimate elements have two irreducible and distinguishing characteristics which constitute their individuality: viz, their atomic number and their atomic weight: the atomic weight being the smallest weight of the element which can be found in a molecule of any of its compounds, and the atomic number being the ordinal number of the particular element in the Mendeleyeev Periodic Table of the Elements.

We know that chemical properties are dependent solely on the atomic number and not on the atomic weight. It is possible to find in nature, therefore, as well as it is possible to produce artificially, isotopes having identical chemical properties but different atomic weights.

We know that an atom consists of a central nucleus and of orbital electrons. We know also that we cannot think of these orbital electrons as so many planets revovlving around the nucleus, for the simple reason that they are energy states, which, in their effects, behave as either waves or particles.

We know that the central nucleus carries a positive electric charge balanced by the negative charge of the orbital electrons, and that the whole mass is practically concentrated in the nucleus.

We know that the positive electric charge of the nucleus is due to only part of its constituent elements, while the rest of the nucleus is made out of electrically neutral elements. We have given the name "proton" to the positively charged nucleons, and the name "neutron" to the neutrally charged nucleons.

We know that the number of protons present in the nucleus of an element corresponds exactly to the atomic number of that element. Isotopes, therefore, having the same atomic number, that is, the same number of protons, can differ only by virtue of their different mass number, that is, the sum of both protons and neutrons.

We know that a loss of mass takes place whenever a particular atom is assembled from the requisite number of protons, neutrons, and electrons. Owing to the equivalence of mass and energy, this means that some small amount of mass needs to be converted into energy to bring about the formation of an atom out of protons, neutrons and electrons. We can surmise, therefore, that if energy was needed to bind the protons and the neutrons of a nucleus together, energy will be released when they are separated.

What we have surmised we have now definitely established and the energy so released has received the appropriate name of nuclear energy.

This new type of energy, like all forces of nature, can perform either destructive or constructive work. Destructive work is accomplished whenever nuclear energy is released instantaneously. Constructive work, instead, may be accomplished through its gradual release as available heat.

The writing of the present article, abstracted from a book I am planning on *Electric Power Stations based on Nuclear Energy*, has been prompted by the timeliness of the subject; for, having learned how to release nuclear energy and how to utilize it for military purposes, we must now attend to its utilization for civil purposes, by distributing it to the industry in the most efficient and the most economical way possible.

(Continued on Page 10)

Mr. Palmieri is a Structural Engineer with Sargent and Lundy in Chicago. He is a member of the Western Society of Engineers, the American Society of Civil Engineers, and the American Concrete Institute.

The information contained in this article is based on declassified material released by the Atomic Energy Commission, and original findings of the author.

(Continued from Page 9)

The most efficient and economical way possible appears at present to be transformation into electricity in power plants expressly designed for that purpose.

To be able to undertake such a design, we engineers must become highly conversant with:

a) The minerals which are fissionable
b) The mechanics of nuclear fission
c) The economics of nuclear fission
d) The chemical problems of nuclear reactors
e) The structural problems of nuclear reactors
f) The problems of heat transfer involved
g) The disposal of radioactive wastes
h) The protection against radiations
k) The recovery of usable materials.

Each of these items will be treated extensively in the forthcoming book, but, for the sake of the present article, we shall suppose that we have already acquired a fair understanding of all the problems involved, and that we are able to proceed to the actual design of the new type of electric power plant.

Let us suppose that we wish to design a 100,000 KW plant, estimated to operate at an average rate, throughout the year, of 60% of capacity.

Our first concern must be, of course, the selection of the basic "fuel." The right selection involves the knowledge of the characteristics of the fissionable materials available to begin with, and, in addition, the adequacy of the material selected for the type of plant projected. In our case we shall use exclusively the isotope of uranium U-235, the main reasons being:

a) The use of natural uranium is not feasible for the type of plant we have in mind to begin with, and, in addition, would be predicated on the U.S. Government's purchase of the by-product, plutonium. This purchase, now actively pursued for military purposes, may be stopped at the time when plutonium becomes a drug on the market.

b) The need of using so-called "Thermal Neutrons" with any combination of the two isotopes U-235 and U-238, implies the use of an expensive "Moderator" such as heavy water, which renders the production of power uneconomical.

c) The adoption of the binary system using Mercury-Water in the transformation of heat into electric energy implies the use of the so-called "Fast Neutrons" because the "capture Cross-Section" of mercury for thermal neutrons is so high that it brings about the absorption of most neutrons liberated by fission.

Having selected the type of fuel, we shall pass next to the consideration of the amount of fuel necessary to generate the required power.

Nuclear physicists tell us that the fission of one nucleus of U-235 releases 200 million volts of energy. But

$$200 \text{ Mev} = 200 \times 1.6 \times 10^{-6} \text{ ergs.}$$
$$= 3.2 \times 10^{-4} \text{ ergs.}$$
$$= 3.2 \times 10^{-11} \text{ watt.sec.}$$

From the above relationship it follows that to generate one watt-second of electric energy requires:

$$\frac{1}{3.2 \times 10^{-11}} = 3.1 \times 10^{10} \text{ fissions.}$$

If the amount of energy released per fission is multiplied by the Avogadro Number (the number of individual nuclei contained in one gram atom, that is, in the atomic weight expressed in grams), we obtain:

$$3.2 \times 10^{-4} \times 6.02 \times 10^{23} = 1.93 \times 10^{20} \text{ ergs}$$
$$= 1.93 \times 10^{13} \text{ watt-sec.}$$

for the energy liberated by one gram-atom.

Therefore, the complete fission of one gram of U-235 releases:

$$\frac{1.93 \times 10^{13}}{235} = 8.2 \times 10^{10} \text{ watt-sec.}$$
$$= 8.2 \times 10^{7} \text{ KW.-sec.}$$
$$= 2.3 \times 10^{4} \text{ KWH}$$

Thus we know that the complete fission of one gram of U-235 releases 23,000 kilomatt-hours of electricity. But, because complete fission is nearly impossible, and because this energy which appears under the aspect of thermal energy must yet be transformed into electric power, we must base our design upon a value much lower than 23,000 KWH per gram. Assuming that the efficiency of the process is about

(Continued on Page 18)

Science Foundation

(Continued from Page 4)

The second function recited in the act is "to initiate and support basic scientific research in the mathematical, physical, medical, biological, engineering, and other sciences, by making contracts or other arrangements (including grants, loans, and other forms of assistance) for the conduct of such basic scientific research and to appraise the impact of research upon industrial development and upon the general welfare." Clearly, the intent of this function is to further the over-all purpose of the act, which is to promote the progress of science. It was intended that the research potential of the country be developed vigorously and extensively, among other things, by increasing the amount of basic research that might be carried on. Its value has a twofold aspect. First, there is the intrinsic value in the contribution that research makes to our store of knowledge. Second, there is the value that lies in the training to do research, especially for the younger group of people who participate in the work.

It must be recognized that when we speak of basic scientific research, we are confronted with great difficulty of definition. For our purposes it will suffice to say that basic research is the kind of research normally done in universities by the scholars on its faculty whose motive is to enlarge the horizons of understanding in their specific fields. In carrying out the second function that has been quoted, the Foundation renders assistance principally to universities in carrying out one of their normal responsibilities.

It is to be noted that in the National Science Foundation Act engineering sciences are specified as belonging to the group of the physical sciences. It raises the question, what is basic research in the engineering sciences? Is it what a professor of engineering does, if left to his own inclinations? Not necessarily. Is it part of the practice of professional engineering? Not insofar as engineering services are rendered to another person or group requiring such services. In discussing this question on another occasion I said that if the penetration and conquest of ignorance is an essential step in research, engineering may lay equal claim with the sciences to the procedure; for the sciences have no monopoly on that which is unknown. Lack of knowledge of ways to apply principles is ignorance as truly as lack of knowledge of the principles themselves. Hence, research directed towards methods of employing scientific principles is research as truly as is the effort to find new knowledge of principles. Engineering research has another ingredient, however. In most cases it is concerned with economic or social aspects of possible results; but this fact makes it no less basic. It seems reasonable, then, to take the view that basic research in engineering comprises the effort to put knowledge of scientific principles in such form as to make it useable in regular engineering practice.

The appraisal of the impact of research upon industrial development and the general welfare is a separate problem to be handled along with another, which is "to evaluate scientific research programs undertaken by agencies of the Federal Government, and to correlate the Foundation's scientific research programs with those undertaken by individuals and by public and private research groups."

Another assigned responsibility is "to award . . . scholarships and graduate fellowships in the mathematical, physical, medical, biological, engineering, and other sciences." This also is designed for increasing the national competence in the field of scientific resarch. One of the problems here is to determine the number and distribution in the awards of grants for fellowships.

The Bush Report laid emphasis on communication among scientists. This was expressed in the Foundation's charter as a responsibility, "to foster the interchange of scientific information among scientists in the United States and foreign countries."

Another duty is "to maintain a register of scientific and technical personnel and in other ways provide a central clearinghouse for information covering all scientific and technical personnel in the United States, including its territories and possessions."

One *dormant* function which, in the event of war, might become an active one, is prescribed as follows: "at the request of the Secretary of Defense, to initiate and support specific scientific research activities in connection with matters relating to the national defense . . ."

Finally, the Foundation is given wide latitude in doing whatever may seem required in carrying out the purposes of the act by the establishment of committees, commissions, study groups and the like, under the general policy guidance of the National Science Board.

An important provision of the act is " . . . it shall be one of the objectives of the Foundation to strengthen basic research and education in the sciences, including independent research by individuals, throughout the United States, including its Territories and possessions, and to avoid undue concentration of such research and education." This is intended to encourage wide geographical distribution of assistance to research and education in the sciences. One can easily agree with the philosophy underlying this requirement, provided, of course, there is wide distribution of those who may qualify for support.

The act includes some specific provisions relating to organization of the Foundation. There is a National Science Board of twenty-four members, appointed by the President, together with the Director of the Foundation, who is also appointed by the President. For lack of time I shall not discuss details regarding the Board. It is a well selected, able group comprising scientists and administrators from around the nation. In general, most of the actions proposed by the Director must be approved by the Board. This constitutes an effective safeguard against any possible bureaucratic control in the future.

As you may already know, the act specifies four divisions within the Foundation, each headed by an Assistant Director, and it is within the discretion of the Board to establish other divisions which it may consider necessary. For each of the divisions there is provided a divisional committee which has general advisory supervision over the program of its division. This substantially outlines the background of the Foundation and its statutory organization.

In the organization, my responsibility is centered in the physical sciences as Assistant Director for the Division of the Mathematical, Physical and Engineering Sciences. This comprises all the natural sciences other than biology and

medicine. To achieve orderly administration we have established five sections within the division—namely, physics and astronomy, chemistry, earth sciences, mathematics, and engineering and metallurgy. The order in which these are mentioned has no implications as to importance. All are important. A Program Director carries the responsibility for administering the Foundation's support for research in each of the respective sections. Staffing has been a difficult task, but we now have a group of highly competent Program Directors for the sections. The Program Director for the Engineering Sciences and Metallurgy is Dr. Ralph A. Morgen, formerly director of the Engineering Experiment Station at the University of Florida.

The Foundation has now had about eighteen months of operating experience within rather severely limited budgets. Initially, the Congress appropriated $300,000 which enabled the Director to make definite plans and moves to assemble his organization. For the first fiscal year of operations, beginning July 1, 1951, the amount appropriated and available in January of this year, was $3,500,000. For the current year, there was an increase of 50% for a total of $4,750,000. A large fraction of the annual budget is needed to support the program of fellowships. Another large fraction is needed for administrative needs, and for carrying out the intentions of the act aside from research support, such as scientific information travel, the national register; and the balance is needed for the direct support of research. Initially, the amount of research support has been divided equally between the biological and medical sciences, on the one hand, and the physical sciences, on the other. During the first fiscal year the budgeted amount was $350,000 for each, but since the biological sciences had a start of some five months ahead of the physical sciences, the amounts actually granted during the 1952 fiscal year were in round numbers $700,000 for the biological and medical sciences, and $300,000 for physical sciences. During the present fiscal year there is available for research support $1,600,000 equally divided between the two major groups. For fellowship support, out of the 1952 budget, there was obligated a total of $1,445,171. The budget for 1953 has not yet been determined.

You will recognize some difficult problems in connection with specific allocations both in the fellowship program and in the program for research support. The first of these is the question of distribution of funds among the numerous individual disciplines that comprise the physical sciences. We do not feel ourselves qualified to sit in judgment and apportion among the disciplines the amount provided in the budget, for this would require more than mortal wisdom. We do not have supernatural insight which would enable us to judge how much each of the disciplines ought to have. We have therefore taken what is probably the most logical course and have said that as a first approximation we shall let the amounts be determined by the scientists themselves from the evidence they bring in by way of good proposals for research which they may wish to do. This has resulted in a distribution of grants as of November 15, by per cent of total dollars, as follows: astronomy 6.5%; chemistry 32.5%, earth sciences 5.5%; engineering 14%; mathematics 7%; physics 34.5%.

The Foundation is in position to assist the higher educational institutions in carrying on their normal research functions by providing grants for research to be done by members of their faculties. Since it is specifically stated in the act that such support may be given through grants, as distinguished from the well-known type of contract which originated in the National Defense Research Committee, the National Science Board decided that the method of the grant should in most cases be employed. It is gratifying that it has been possible to develop a method so simple that it imposes no hardships in its administration. Briefly stated, a proposal is received from a scientist, in which he outlines, in accordance with directions issued by the Foundation for preparing a proposal, the problem on which he wishes to work, the estimated period for which the grant is sought, and the amount requested of the Foundation to support the work. In the Physical Science Division, the proposal is sent to a consultant-specialist in the field of the proposed research, who acts as one referee and who supplies the staff with names of several additional referees. Each of these also receives a copy of the proposal and in due course the appraisals of the several referees are brought together in the Foundation and reviewed. On the basis of the evaluation for merit of the proposal, this and other proposals are then reviewed by the staff, comparisons of merit are made, and finally a list of meritorious proposals is given a review by the senior staff, as well as by the administrative and legal divisions of the Foundation—whereupon the Assistant Director of the Division submits the list to the Director, who then presents it to the National Science Board for approval. Approval by the Board authorizes the Director to make a grant, which is done by a letter from the Director notifying the institution of the grant, its amount, and the simple conditions that apply. These conditions are necessary for the reason that public funds derived from the taxpayers are being disbursed. The important fact is that there is no contract covering many pages of fine print, requiring analysis by a lawyer, and that there is no extensive or complicated accounting which would burden the institution with a great amount of addi-

(Continued on Page 14)

(Continued from Page 13)

tional work. A grant may include such items as cost of special equipment needed, one or several graduate assistants, technicians, expendable supplies, a small amount of necessary travel, communication and expenses of publication of results. Equipment which is procured or constructed becomes the property of the institution.

Thus far in engineering, we have received 91 requests for research grants, amounting to $2,274,000. Of these, 41 proposals have been found to have merit enough to warrant support for a total of about $484,000. Within the budget limitations, 13 grants have been made in a total amount of $127,000. In the entire division of the Physical Sciences, the total number of applications has been 423 for a total of $7,700,000, with 229 meritorious proposals for a total of $3,800,000. The total number of grants awarded in the Physical Sciences is 88 for a total of $920,000. Roughly, for each $5,000 of the total, one graduate assistant is provided the principal investigator.

In the fellowship program which is the responsibility of the Division of Scientific Personnel and Education, the National Science Foundation has taken over the program previously sponsored by the Atomic Energy Commission, except that the Commission is carrying forward the fellowships for which it granted renewals. The Commission is also continuing certain specialized fellowships specific to its operations. The Foundation made one change, in that it has provided for fellowships during the first post-graduate year on the basis that this is a somewhat critical point in the educational career of the student who has completed under-graduate work in the sciences. The large demand for his services in industry, as you know, resulted in salaries that must prove exceedingly attractive to the young person who at this point must judge between taking a job and continuing his education. If well qualified college graduates are to continue their education in increasing numbers, financial aid must be provided for many of them. The National Research Council, operating under a contract with the National Science Foundation, has made available its valuable experience in handling fellowship programs, and has done the necessary screening and classifying of applicants, to the point where the Foundation staff in the Division of Scientific Personnel and Education could determine to which applicants fellowships were to be offered.

One of the interesting—not to say provocative—problems is that of support for those relatively smaller institutions which have not been in position to encourage and foster research among the scientists on their faculties. As yet we do not have more than a partial answer to the problem. It is recognized that many of the liberal arts colleges contribute impressively to the number of graduates in the sciences who continue to the doctorate, and follow a career in science. You are undoubtedly familiar with the interesting information that came out of a study some years ago by the National Research Council, on "Baccalaureate Origins of Phd's in the Natural Sciences," 1936-1945, which showed that there were scattered about the country a number of such institutions where the ratio of those who became career scientists to the number of science majors at the under-graduate level in a particular institution was exceptionally large as compared with the national average. Dr. Trytten of the National Research Council has informed me that in addition to the colleges thus discovered, there are likely to be between 50 and 100 more which could similarly distinguish themselves if the right kind of encouragement and support could be given. The means for doing this remain still to be developed. One possible approach to the problem is to locate the superior young men who have recently completed their doctorates and who have chosen a career of teaching in the smaller colleges. It may be possible to find them and keep their interest in research alive by some proper method.

In connection with its evaluation function, as specified in the act, the Foundation has established an office of Program Analysis which is active in collecting data pertaining to funds spent for the support of basic research in non-profit institutions by the government agencies which are in position to provide such financial aid. Analysis of the data will, it is hoped, show what kind of support is given to the various fields of science and this, together with other information that may come from the study, will begin to provide the kind of background information needed in making intelligent decisions regarding the distribution of funds for the support of research.

It should perhaps be said in conclusion, what undoubtedly you have perceived in the course of this discussion, that the National Science Foundation is still in its formative period, during which many policies remain to be developed and operating procedures established. Perhaps the most pressing problem is that of doing justice to the many responsibilities assigned to the organization in the act, within the exceedingly limited funds thus far available for all of the actiivties involved. This becomes a matter of increasing the understanding on the part of the public of the important role which science must play in the national picture and thus to increase congressional recognition of the needs of the nation in matters of science. The Congress established the National Science Foundation for the benefit of the people of the United States. It can develop the intended benefits only through the scientists themselves who, I think, must regard themselves as the unofficial trustees for the public. The Foundation, although it belongs to the people, can succeed only through the support and the interest of the scientists. The immediate benefits accrue to *them*, and *through* them to the nation, and indeed to society as a whole. There is still much to be done before we can say that we are fully on the way to achieving the many objectives which constitute our national policy for science. With the help of the scientists, and I include engineers as members of the body of scientists, it will be possible for the Foundation to become what it was intended to be when the act was written.

Engineer Managers

(Continued from Page 5)

ual approach to the problems encountered in industry, based upon engineering processes, products, and services. Many companies do not now have this high percentage of engineering graduates but they should gradually build up to a higher and more adequate proportion.

Whether a company is increasing its proportion of engineers or continuing on a normal basis, it should employ a certain number of new graduates each year. I mean each and every year whether business is good or bad. One of the mistakes which many companies make is to take on fewer graduates when times are a little slack. This leaves a gap in the supply of properly trained men a few years later when they will need more men than they will then have. For instance, we all short-changed the engineering graduates during the depression of the thirties, and subsequently we needed them badly during World War II. In 1949 all of the available engineering graduates were not given proper jobs and, as a result, a shortage is being experienced today.

Hiring the proper quota of new graduates is not enough. They should be enrolled in proper training courses and given every opportunity to learn the business and develop into positions of responsibility and leadership. To help industry do a better job in such training is the purpose of Mr. Montieth's activities in ECPD during the past few years.

I will not go into detail regarding the training course itself but I would like to express some opinions about the problems of the later advancement of these trained engineers through the upper echelons of the company.

Engineering graduates, while they have received the correct basic engineering training, are human beings with differences in temperaments and abilities in both technical and administrative fields. To successfully man a company with engineers requires considerable development of the men over and above what they are when they receive their diplomas.

The usual organization chart is drawn to show the line of authority running down from the top. It should also be looked upon as the path for advancement from the bottom upward toward the top position of president.

Upon completion of the training course, the engineer is usually assigned to a department in a particular division and then, for a time at least, left to the mercy of whoever happens to be his immediate boss.

I think the education department should have a continuing interest with some cooperative authority to make sure that the individual is treated fairly with reasonable assurance that his advancement will be the greatest of which he is capable.

At some point in this upward progress, each man should become known personally to the top management so that he will be properly evaluated and given every possible chance for deserved promotion insofar as justified by relative competitive abilities.

Now a word about engineers for top jobs in comparison with men trained in the legal, financial, or "business administration" fields.

The top executives should form a strong team, proficiency in finance, sales, production, and invention. Each and every one should know the product in every detail, and especially from the customers' viewpoint.

The customer is all-important and a full knowledge of his needs and future trends should be known not only by the sales department but also by the production and engineering departments, and especially by the president. As the products and services of industry are largely within the engineering field, it is best that all members of this management team should be engineers or men with an engineering background who have advanced on their own initiative into fields of finance, sales, and management.

Some lawyers and bankers have become very engineering minded and have used good judgment in making major decisions regarding engineering, research, and development problems when they have confidence in and give opportunities to the engineers in the team to analyze and evaluate the problems properly.

The degree of success of a company rests almost solely with the president or top executive officer. It is he who selects the vice presidents and top staff and establishes the policies and methods for coordinating the different divisions and departments.

Many of the most successful companies, large, small, and intermediate in size, have done very well in the training and advancement of engineering graduates throughout their organizations up to and including the presidency.

Those that have not done so well in this respect simply do not grow and prosper. They either limp along, or fail, or are absorbed by others. When a successful company makes some changes that are not for the best, it may be several years before the mistakes are fully realized, because a going concern can drift for some time upon the reputation and momentum of the past.

Many of us can relate cases where improvements should be made, but it is best to study factual data of successful companies for the benefit of all. The engineering profession should present to the top executives of American Industry illustrative factual data relating to the successful use of engineers in such an effective manner that all will strive to improve their present methods for selecting, training, and advancing engineering graduates within their respective companies.

At the Annual Fall Dinner

ABOVE: Dr. Paul E. Klopsteg, guest speaker, Assistant Director of the National Science Foundation.

BELOW: Ovid W. Eshbach, President of WSE, and Dean of the Northwestern Technological Institute.

ABOVE, LEFT TO RIGHT: George L. Jackson, Mrs. Dot Merrill, William B. Ferguson and Charles L. Mee.

ABOVE, LEFT TO RIGHT: J. Earl Harrington, William R. Marston, and Albert P. Boysen.

ABOVE, LEFT TO RIGHT: Charles E DeLeuw, H. P. Sedwick, Dr. Paul E. Klopsteg, and Ovid W. Eshbach.

BELOW, LEFT TO RIGHT: Donald N. Becker, John F. Sullivan, Jr., and John T. Rettaliata.

Jet Transports

(Continued from Page 8)

props, and a fourth turbo-prop, the Britannia, under development—shows good appreciation of the speculative nature of aircraft design, and of the fact that design is an art which must be practiced continuously for success, with design experience building on itself to produce that unique product, the effective airplane.

The challenge to which the United Kingdom responded so vigorously we on this continent shirked. The Canadian aviation defense programme was a demanding one, and a heavy one—how heavy you will be able to judge for I shall digress a moment to outline it for you. In the same year, 1946, that A. V. Roe Canada Limited commenced the design of the *Jetliner*, the company was commissioned by the R.C.A.F. to design and develop an all-weather, twin-engined jet fighter, the *CF-100* for use in the defense of northern Canada (no suitable fighter being in existence), and a 6500-pound thrust turbo-jet engine, the *Orenda*, to power it. Prototypes of *Orenda*, *Jetliner* and *CF-100* were completed in 1949, a remarkable achievement, especially for so untried and so recently formed a design staff. Two prototype *CF-100's*, powered by Rolls Royce *Avon* turbo-jets were produced, and an *Orenda* version developed. Pre-production fighters are now in training service with the R.C.A.F. The *Orenda TR5* engine has left the prototype stage and is going into full production. Other phases of the programme are as follows. At Montreal, Canadair Limited is in production for the R.C.A.F. and the U.S.A.F. on the single-engined jet fighter the North American *Sabre, F86E*, and a *Sabre-Orenda* has also been turned out. Canadair Limited is going into production for the R.C.A.F. on Lockheed *T-33* two-seat trainers which are powered by the 5000-pound thrust turbo-jet engine, the *Nene*, which is to be assembled in the new Montreal plant of Rolls Royce, Limited. For the U.S.A.F., Canadair is building the piston-engined Beechcraft *T-36* trainer-transport in the design of which the company assisted. DeHavilland Aircraft of Canada Limited is producing for American use its own light liaison aircraft, the *Beaver*, which won an American military design competition in 1951. Canadian Car & Foundry Company Limited will produce the ab initio trainer Beech *T-34* for the U.S.A.F., and is currently building *Harvards* to be used as intermediate trainers by the R.C.A.F. Canadian Pratt & Whitney Limited has built a new plant at Montreal to assemble *Wasp* engines for the *Harvards*. These are the main suppliers, but subcontract work for them engages the full capacity of many hundreds of other manufacturing firms both large and small. The whole constitutes a well-integrated, single-valued programme aimed at providing Canadian sources of supply for the equipment needed for training and defense by the R.C.A.F., and by the air forces of other western nations.

The need and importance of this military programme with its wise emphasis on self-reliance, is understood and appreciated. With the example of the United Kingdom before us, however, to offer it as an excuse for our failure to

(Continued on Page 18)

(Continued from Page 17)

meet the commercial challenge of our times is to deny our purpose and function as an industry. The true explanation is that our resource and will failed to live up to the demands made upon them. This lack of resource, or more accurately, loss of resource is prehaps directly attributable to the cumulative effects of 13 years of concentration on military projects. The enormity of war and the immediacy of its needs stultifies civilian values, and annuls civilian critical faculties. Moreover, the habit of accepting military technical aims as the only important aims, closes the mind to the value and necessity of making efforts also in other directions, while long and close association with military attitudes and procedures reduces independence of thought, and channels initiative away from all other fields. Comparison of the pre-1939 Canadian aviation industry with that of today shows that today's is much larger and much more stable financially, but that it no longer sets its own policies, dictates its own design programmes, controls its own operations, builds and owns its plants, having placed its initiative and independence in pawn for that expansion and security. Moreover, the new cleavage developing between civilian and military design fields weakens the civilian position still further.

In the past, the military and civilian research aims were roughly identical, and the civilian designer leaned on military objective research for technical information and the pioneering of new inventions and techniques. Now, as Sir Harry M. Garner has pointed out, the civilian designer can no longer rely on military research for assistance, for the two fields diverge widely, the very speed regions to which each aspires showing the extent of that divergence. The military designer focuses attention on the transonic region where compressibility introduces problems of instability and high drag, and on the supersonic region where frictional heat brings temperature rises that call the strength of the structure into question. With his mind on the robot and the rocket he seeks design formulae for the truly high speed machine. His success will make today's military aviation a thing of the past, the rocket-propelled guided missile rendering obsolete today's interceptors and bombers, and tomorrow's pilotless aircraft.

However, in the meantime, the civilian designer is anchored to the subsonic region until such time as his ingenuity can insure complete reliability for those conditioning systems upon which the well-being of his passengers depends. Right now he needs applied research on improved control systems, operational economy, safety devices for landing and taking-off, and aerodynamic or mechanical means to increase aircraft effectiveness. That modern military research will not provide answers for his pressing problems, our current R.C.A.F. Research and Development Programme demonstrates only too plainly. Supersonic research, wind tunnel and structural testing for the *CF-100* fighter, radar development and research, missile aero-dynamics and control and the development of the air-to-air guided missile, operational research in connection with air defense, aviation medicine, new techniques in air navigation, and de-icing research are projects that will not further commercial design greatly. Moreover, since they tie up our entire aeronautical research facilities, they reduce the field of Canadian aeronautical research to their own confines, and limit broad aeronautical development. Every aeronautical engineer whose perspective extends back 20 years must question the wisdom of continuing this policy indefinitely.

Perhaps the initiative responsible for the *Jetliner* came originally from the United Kingdom, the home of the parent company of A. V. Roe Canada Limited. The response it aroused in Canada was Canadian, however, and the project continued as a vigorous Canadian effort until the crisis developed in Korea and the tempo of military production was stepped up. With that the effort died, either because a growing military "blind spot" limited Canadian vision to military prospects, or because Canadian will and resource did not measure up to the challenge—or both. The original and strong contender, the United Kingdom, was left the only contender in the field. If time shows that the initiative in airliner design has indeed passed to the United Kingdom, the explanation will lie in the circumstances that, despite a heavy military load, the United Kingdom alone had the will and resource to undertake the commercial exploitation of the aircraft gas turbine engine and to push it to a successful conclusion.

Atomic Power

(Continued from Page 10)

25%, we shall expect to produce from one gram of U-235 about 6,000 KWH of electricity. This means that we must be ready to "burn" about 10 grams per hour, or 240 grams per day, or, roughly, assuming a slightly greater efficiency, one half pound per day.

With such an assumed degree of very low efficiency, the cost of fuel at the current price of uranium will amount to 3.3 mills per KWH. It is clear, therefore, that any increase in the efficiency of the whole process will go a long way towards establishing it competitively, as regards cost, with the conventional methods of electric power generation. We engineers must never lose sight of the fact that electric power based on nuclear energy is something more than a problem of pure science; actually, it is an industrial problem in which the economic factor is still paramount.

Passing from the consideration of the fuel to the consideration of the machinery which will make up the new type of plant, we shall begin with the discussion of the "Reactor," the "furnace" in which nuclear fission generates the heat that is to be converted into electric power.

Nuclear physicists tell us that the power developed in a reactor is proportional to the average "neutron flux," and to the total number of nuclei of U-235 present.

But this is only the beginning of the story, for the story of the design of a reactor devised to produce 100,000 KWH of power is yet to be written. This article can only summarize what will be treated more thoroughly in the contemplated book. Suffice it now to state that there are already quite a few reactors in operation throughout the world, but none, to my notion, of the type appropriate to the design of this hypothetical plant. The reactor I have in mind will utilize U-235 in a slurry made up of a mixture of very fine particles of this isotope kept in suspension in rubber latex. This slurry will be pumped into the reactor as the need arises, eliminating thus the danger of too heavy a concentration of U-235 at any time, the reactor being furnished with a small core of U-235 in bulk, or an additional artificial neutron source. As material for construction of the reactor, we must rely on concrete reinforced with fiberglass.

Within the reactor will circulate rubber pipes filled with mercury. Because it is expected that the heat will rise to a temperature greater than 357 degrees centrigrade, the mercury will be vaporized inside the reactor, and, in so doing, will act as an effective coolant while at the same time utilizing this heat for a mercury-water binary-fluid cycle.

The introduction of a binary-fluid cycle is imperative if we want to utilize the enormous increase of temperature at which the fluid receives energy at its source. In such a compound cycle, the energy rejected from the condensing mercury will constitute the source of energy needed for the vaporization of water.

Our power plant will consist, therefore, of:

a) The slurry tank and relative pump.
b) The mercury tank and relative pump.
c) The reactor and its control mechanism.
d) The mercury boiler to be designed for vapor pressure above 200 lb. per sq. in. and temperatures greater than 1,000 F.
e) A double stage mercury vapor turbine designed for one half of the total power generating capacity of plant.
f) A pump carrying feed water to two "Condenser-Boilers."
g) Two condenser-boilers where vapor mercury is condensed to liquid mercury, and water, instead, is vaporised.
h) Turbines, dynamos, condensers, pumps, piping, etc., as per conventional power plants (without boilers) designed for the other half of total generating capacity of plant.

My preliminary studies indicate that a plant of this type would cost in round figures about $20,000,000, or $200.00 per kilowatt-hour. This cost is well in line with the present cost of a fully enclosed conventional power plant of similar capacity. The amortization of these $200 per KWH, together with fixed charges on investment, will average 3.5 mills. This means that in making an estimate of the total cost of atomic electric power we shall charge:

a) Fuel costs	3.3 mills
b) Capital charges	3.5 mills
c) Operating costs	1.2 mills
Total	8.0 mills

This cost, although greater than the present cost of electricity by, perhaps, two mills, is related to a 25% efficiency; a low enough figure assumed for the time being as a probable starting figure. It is to be expected that with the progress of technology, this cost may be, consequently, brought in line with current power plants.

Crerar Library
Notes and News

Two new abstract bulletins will be added to the Library's list of publications in 1953. LEUKEMIA ABSTRACTS will be published monthly beginning in January. It will be issued jointly by Research Information Service and the Medical Department under the editorship of Mr. Don Nist. It will be supported by a grant from the Lenore Schwartz Memorial Foundation.

ABSTRACTS OF BIOANALYTIC TECHNOLOGY will be published quarterly for the Council of American Bioanalysts under a contract with Research Information Service. This publication will undertake a more thorough analysis of the literature of this field than is now available in any of the other abstracting services.

* * *

More than a year ago the late Miss Emma Crandall, research chemist and long-time user of the Crerar Library, deplored the dirty walls in the reading room of the Technology Department on the 14th floor. To help correct this situation, she offered a donation to help defray the expenses. The work could not be done at that time and we are sorry that she is not here to enjoy the newly decorated Technology Reading Room and Catalog Reference Room.

As a final step in the remodelling of Library quarters, the staff now has attractive rooms on the 9th floor, north of the Chicago Medical Society offices. In addition to locker and rest rooms for the women members of the staff, there are a large lunch room with a well-equipped buffet kitchen and a special room for the staff library. The latter not only contains professional books and periodicals, but also a good collection of general reading matter for the personal use of staff members.

* * *

The Library's interest in foreign patent specifications has been reported recently in this column. Reference was made then to a gift of recent Swedish patents from the University of Minnesota. It is a pleasure to expand this announcement with a note that Crerar will receive from the same source a complete file of Swedish patents from 1885 to date.

Conference

Maketh a Ready Man

—*Bacon*

Bacon was thinking of you, of me, and of the team captains selling WSE memberships.

We know that the job of selling WSE is easy but takes dogged perseverance. We know that the Society is good, and we sell individuals personally. The Society fills an inspirational and economic need in our engineering lives, and 2900 of us have confidence in WSE. We offer WSE to the thousands of Chicago-area engineers.

The reward to each member selling WSE is a Command of Presentation. That Command lifts the engineer high in the leadership of his industry.

So stand behind us. The Society is ready for a two-fold increase in membership. And we can get that increase if each one of us goes out and gets a member.

HENRY COFFMAN, Chairman

LEE BIRD, Assistant Chairman

Membership Committee

An Engineer from a Foreign Land

By Paul Rogers

I was actually born in Upper-Slovobia in a picturesque little town with an unpronounceable name, and I had the traditional growing up dreams, such as of joining the cavalry, and rescuing beautiful maidens.

When I was about nine years old, Upper-Slovobia lost the war. Lower-Slovobia did not win it either, but she was smart enough to declare war on the Central Powers just in time to be considered as one of the Allies, an idea many countries applied successfully in the last war. As a reward, Lower-Slovobia was awarded practically half of Upper-Slovobia. My home-town was on the Upper-Slovobian border. The story goes that the surveyors who staked out the new frontier skipped classes when temperature corrections for chains were taught. Anyway, they made a few yards mistake and thus made me a Lower-Slovobian citizen.

After a brief career as a bank-clerk, I decided to become an engineer. I registered with one of the Lower-Slovobian colleges and sat down in the class to study. But the profesor didn't show up. He was the son of a prominent politician and was named full professor while still studying in Paris. I figured that there was no use waiting for him, so I packed and went to a foreign country myself to become a civil engineer.

Lower-Slovobia, famous for her beautiful queen, has always had conscription, and in due time I had to register for it myself. Being drafted is quite an affair over there. One starts by undressing in a large room and leaving all his clothes behind. He takes a shower and then marches before some medical and other officers. If he can walk, he is in. By the time I went back for my clothes, they were gone and some dirty rags were left in their place. I couldn't walk to the other building unclothed so I put them on and thus I looked exactly like 98% of the other draftees.

In the other building we came before a sergeant who loked at me suspiciously, probably because I washed my ears, too. Can you write, he asked. Sure, I answered. Officers' training school, he declared.

After a few months in the school, where we brushed up on our readin', 'ritin', and 'rithmetic, we were sent to our regiments. Engineer Corps only existed on paper so they made me a skitrooper. There I soon became the colonel's favorite. We both played the violin and with some other fellows, we played chamber music regularly.

Soon they discovered my other talents also. I could type, thus being the second man in the regiment who could handle the infernal machine. They assigned me to a captain who was writing a long thesis on anti-aircraft defense. I typed that for him. His pet idea was to shoot down enemy bombers with machine guns. Despite the fact that airplanes were at that time flying pretty high already didn't seem to bother him a bit. He soon was promoted to be a major.

Next, I was called upon to teach a class. I was looking forward to my class with great expectations and quickly brushed up on differential-equations and the like. Then I learned that I had to teach the enlisted men how to read and write. With 68% of the regiment completely illiterate, that was no joking matter.

Shortly afterward, I also was given engineering work. We had maneuvers and each battalion had to dig a lot of trenches. The regular officers obviously were well versed in the 16th century Turkish warfare, because they began digging useless and meaningless trenches by the hundreds. Then, after the beautiful grain and cornfields were thoroughly ruined, some bright boy from the War Department, probably a foreign graduate, issued an order that those trenches should be accurately mapped. One of our regular captains was supposed to be an engineer, but he couldn't even read blue-prints, let alone make them.

I got the mapping assignment. I then asked for an assistant to hold the rod. I was told to choose one who was technically trained so I chose a friend of mine who was a lawyer. We were given a couple of fine horses and we sure had the fine life for a few weeks. However, we made an honest effort to map the trenches as they were dug, and thus came up with the most complicated-looking drawings anybody ever saw. We promptly were given long furloughs.

Then I was transferred to a large port and helped build pontoon bridges over a wide river. Of course, we had no trucks or other equipment. But we did have plenty of husky peasant soldiers, so we carried the pontoons on their shoulders, sixty per pontoon.

We also had a winter manuveur. There I helped build a ski-jump. With the cheap labor supply, that was easy. A Lower-Slovobian soldier got one cent a day; but even that was usually stolen

(Continued on Page 22)

Mr. Rogers is a Structural Engineer with Sargent and Lundy in Chicago. Besides being a member of the Western Society of Engineers, he is a member of the American Society of Civil Engineers.

This article is based on Mr. Rogers' experiences in the Rumanian army.

(Continued from Page 21)

from him. It was so easy to put crosses on the pay-roll.

A reservist was sure of one thing, though. He would not be mistaken for a regular officer. The latter, with his tightly drawn corset, lipstick and face-powder, fancy uniform of many colors, always followed by several orderlies, was a sight only seen by Americans in comic operas. The number of orderlies allowed for regular officers varied with rank from two to twelve. This naturally developed into a nice racket. Many so-called orderlies have spent their time at their home, working or carrying on with their businesses, and have shared their income with their respective officers.

I venture to say that the soldiers never really understood me. Although it was customary to slap, kick and beat them any way you wished while using profane curses on them and the female members of their families, my western education never let me act similarly. I suppose the boys thought I was really mad at them since I didn't even beat them. The right of beating goes with the rank. The private first class beats the private, the corporal the p.f.c., the sergeant the corporal, and so on.

One could ask, just what was such an army good for. Not for fighting, by any means. They never were expected to fight an enemy and indeed they never did. The Lower-Slovobian army, with a standing force of 6 to 10 per cent of the population, was only used for home consumption, mostly to keep the people in their places. However, this not-so-glorious and never-victorious army was utilized in the last war as an occupational force over a segment of her neighboring country. They distinguished themselves there by selling—for good cash—armament, munitions, and even complete artillery to the guerillas of the occupied country.

I had found the hopeless life in Lower-Slovobia unbearable and emigrated to this country. Here I have found, in addition to the many material benefits, the two most precious things in life, freedom and human dignity. Thus, when the time arrived to become an American citizen, I requested that my name shall be changed from U. L. (Upper and Lower) Slovobian to J. P. (Just Plain) American.

WSE Personals

Robert K. Matthews, formerly a construction engineer with Freyne Engineering, is now Assistant General Superintendent of Construction, Koppers Company, Inc., Koppers Building, Pittsburgh, Pa.

W. F. Kinnucan, Jr., formerly a Detailer with American Bridge Co., is now doing details as a private in the army. Kinnucan was outstanding in Basic Training, and was the top man in a Leader Course of 8 weeks duration in which 35 men enrolled but only 18 graduated. Now awaiting OCS orders, Kinnucan plans to join the army's jump school, then the Rangers upon receiving his commission.

T. Ray Maslanka, until his recent promotion, was Assistant Superintendent of Construction and Maintenance with the Standard Oil Company (Indiana) in Chicago. He is now Superintendent of Construction in the Peoria Division of the same company.

Dr. Gustav Egloff, Director of Research of Universal Oil Products Co., sailed on November 21 on the "Liberte" for Spain, to give a series of lectures, which started December 2. He is to address the Instituto del Combustible (Institute of Fuels) Madrid, on "Present and Future Motor Fuels and Lubricants;" the Instituto "Alonso Barba" de Quimica, Madrid, on "Catalysis in Petroleum Refining;" La Laguna University, Teneriffe (Canary Islands) on "The Evolution of Petroleum Refining Technology" and also will address oil and other groups in Spain on "Living Off Petroleum." He will visit the refinery of Compania Espanola de Petroleos (CEPSA) in Teneriffe, where a UOP Platforming unit is being installed, and will also visit the Caltex refinery at Carteghena, and other places of interest, which visits are being arranged for him by CEPSA. Dr. Egloff's plans now are to return on the "United States" on January 24, arriving in the States on January 28, 1953.

James E. Peterson ('50, M), of the Chicago and Western Railroad Co., has been appointed Office Engineer, Dearborn Station, Chicago

Carl G. Muench's retirement as senior vice-president has been announced by The Celotex Corporation.

An authority on fibreboard manufacturing techniques, Muench has been associated with the insulation board industry since 1910. That year he assisted in the design and construction of the Flaxlinum Insulating Company plant at St. Paul, Minn., which he also operated for a number of years. In 1914 he became associated with the M & O Paper Company at International Falls, Minn., where he designed and built machines and plant for making the first rigid insulating board. In 1920 he joined a group

that organized the present Celotex Corporation. He was responsible for the designing and building of the machinery and plant at Marrero, La., which he managed for many years.

Muench has held the position of vice-president and director of The Celotex Corporation since its organization. He will continue as a director of The Celotex Corporation.

He is now living at Rancho Santa Fe, California.

Burdette E. Sanderson ('50, M), of Public Service Company of Northern Illinois, is now the Division Manager, Commercial Sales, at Dixon, Illinois.

O. H. Gosswein, Technical Service Manager, Chicago, is retiring after an outstanding career of more than 35 years service with Universal Atlas Cement Company, a subsidiary of United States Steel Company.

Born in Lafayette, Ind., Gosswein attended Purdue University in that city and graduated with a degree in civil engineering. His career with Universal Atlas began in 1917 as a field engineer. In 1930, he was promoted and became technical service manager, which position he held until his retirement.

Gosswein is a member of the Western Society of Engineers, American Concrete Institute, Chicago Engineers Club and the Chicago Association of Commerce. Many of Mr. Gosswein's technical papers on cement and concrete have been published. He will remain in Chicago.

Claude C. Bowers has retired from the Western Union Telegraph Co. Bowers joined Western Union in 1916, and has a total of nearly 46 years in that line.

From 1916 to 1921, Bowers had a considerable amount of labor trouble with which to contend, and finally got a Federal Injunction against Mike Doyle, a leader of the labor forces.

Bowers was for many years the Metropolitan Plant Superintendent. After Western Union's reorganization in 1949, he retained his position, but received the new title of Area Plant Superintendent.

In World War II, Bowers was active in civilian defense. He also has been active in WSE.

Ellet Award Competition Still Open

The Junior Division of the Western Society of Engineers announces the opening of the Charles Ellet Award competition for 1953.

This award was established in 1929 by a gift from E. C. Schuman, a Junior member, and is symbolized by a beautiful loving cup on which is engraved the names of the recipients and the names of their respective schools. The cup is on display at the WSE headquarters. As evidence of the honor bestowed, the winner receives an engraved certificate and a prize of $25 in cash.

All members under 30 years of age are eligible. The award is made to the member who, in the opinion of the committee of awards, is adjudged to have excelled in the preparation and presentation of a technical paper presented in competition for this award at a meeting of the Junior Division.

All younger members of the society are urgently recommended to consider entering this competition. It offers an excellent opportunity for the younger engineer to obtain recognition for his endeavors as well as an ideal opportunity for him to acquaint himself with the various aspects of paper preparation and presentation. Such experience could be invaluable to him in his future professional career.

Formal entrance into the competition may be made by writing the Society headquarters, stating your intention and the subject of your paper.

Further information may be obtained by contacting Society headquarters or Don Klusman, at OF ficial 3-9300, Ext. 4834.

Science Makes Possible Our Living Standard

Science has enabled Americans to reach the highest standard of living enjoyed by any people any time, Dr. John T. Rettaliata, Member of WSE, and president of Illinois Institute of Technology, declared December 5 at a dinner meeting of the Law Club of Chicago.

"Without science," he said, "disease would stalk the earth. Without technology, communication would be a matter of mounted couriers and beacon lights on hills.

"Women would be condemned to drudgery in the home. Farming would be a form of serfdom instead of the high professional occupation to which science and technology have elevated it."

The gains are not all material, he continued; many social gains spring from science, and the belief that it contributes little to the nonmaterial advance of civilization is the heart of the challenge to science.

He pointed out that science, technology, and production are bringing abundance within reach of all for the first time in history.

"It has always seemed to me," he said, "that socialism consists essentially of a leveling *down* process. Science, technology, and production are showing us how all men may be leveled *up*."

As to the atomic bomb, Dr. Rettaliata expressed the belief that its discovery may not be as bad for us as we think. First, it and other technical achievements have enabled us to keep Russia at bay.

"Second," he said, "the bomb has vastly widened man's possible choice of good or evil. I cannot but reach the conclusion that the choice of evil use is about to become virtually impossible. Science is compelling all men to think in terms of ultimate values and ultimate ends."

Engineers Inactive in Home Building

"Engineers have played too small a part in the home building industry, and as a result the industry is behind the place where it should be today," John C. Taylor, Jr., President of American Homes, Inc., said before the American Society of Mechanical Engineers on December 4.

"The building of homes constitutes the greatest potential market in the world. Every part of the world is in need of homes. In fact, the number of millions needed almost staggers the imagination.

"One of the greatest handicaps in most countries is lack of suitable materials out of which houses can be built economically. South America, for example, has much lumber but only a fractional part of it is suited for housing. Masonry in the form of adobe, cement or brick is available in most countries, but it is expensive in terms of money and manpower. It is heavy and in most instances transportation facilities are inadequate. The construction period is much too long if the program of housing is to be solved.

"In Israel, Greece, Brazil, India, Cuba, Indonesia and many other countries the cost of homes built today transformed into the wages of the average worker represents as much as 10 years of gross income. In our country we think in terms of two and one half times the gross income for a year as a reasonable price for a home, and yet here, costs are too high to meet the demand in many classifications.

"Weight is another important retarding factor—because transportation is a real factor in cost. It has been estimated that in a four-room house built in this country of a 700 to 720 square foot area, there is involved approximately 21,000 ton miles of transportation.

The House of Tomorrow

"I want to describe a house and a method of building it and present to you one possible way of overcoming a large part of the 'road blocks' which we find in our paths. Aside from the foundation, a house is made up of five main parts plus mechanical equipment for heating, lighting, plumbing, and, in some instances, air conditioning. The five parts are: floor, exterior walls with openings, interior partitions with openings, ceiling and roof. The function of each of these five parts is well known. The required characteristics as to strength, rigidity, resistance to weather, etc. are all a matter of record. Testing procedures have been well established. We know what we need and we know how to find out when we have it. We know the cost of each of these parts broken down into materials, labor, transportation and financing. In short, we know what we have to work with pricewise.

"We know that we can ship by truck over our highways panels 32 feet long by eight feet wide. Therefore, we should have in a 24- by 32-foot house only three floor panels eight feet by 32 feet. These panels must be complete with finished surface, insulation, sufficient strength and rigidity to meet all floor requirements for housing, and placed at an eight-foot span. The weight must not be more than four pounds per square foot.

"For our exterior walls, a similar material or composition of materials out of which, in a factory not more than 350 to 400 miles from the site, can be asembled full wall sections, with windows and doors and insulation, up to 32 feet in length and up to eight feet in height, and weighing not over three pounds per square foot. The same is needed for partitions, with the weight not exceeding two pounds per square foot, and for ceilings with the weight not exceeding two pounds, and roofs with weight not over three to three and one half pounds. Using such a material, we would enclose a house with three floor panels, four side walls, two gables and not more than four roof sections, a total of 13 pieces, each of which could be unloaded and erected by hand labor at the site.

"Such a material or composition of materials as I described will fit in beautifully with current architectural trends. Transportation costs would be at a minimum; field erection as to time and cost would be at a minimum. In fact, if your foundation were ready, building a home should be a matter of a few days at most, for each erected part would be completely finished except for the final coat of paint, in case the material used needed painting.

"One of the expensive items in houses today is the equipment for heating, also for lighting and plumbing. Even in our prefabricated houses, these jobs are done by subcontractors in the same manner as they are done for conventionally built homes. Once we have worked out our goal of building the house enclosure as we think it should be built, the improvement in the mechanical gadgets will follow. Our panels will be shipped wired, cutting for the trades will be done and all the equipment will be shipped for rapid installation.

"Spread all over such a development must be the engineer to develop the basic material, work out connections, and develop new mechanical equipment and a thousand and one requisites.

"When and if the panel such as I describe is produced, I think it will be of laminated or the so-called sandwich variety. An exterior wall, for example, will be made of two sheets of material, one providing interior finish and the

(Continued on Page 26)

Your Pet Project MAY BECOME A PRIZE PAPER

Jot down the ideas you've had for a long time . . .

Maybe they'll help you think of others . . . Maybe they'll win you one of the five, $100 prizes

Here are the rules:

Any member of the Society may compete regardless of grade of membership.

Papers shall not be highly technical in nature. A clear, concise and interesting coverage is desired rather than complex formulae or derivations. The subject discussed should be of general interest to engineers but should not be of a political or highly controversial nature.

All members of the Society who wish to submit papers in this contest should contact the Secretary as early as possible and not later than February 1, 1953, and request a copy of the rules governing the competition and an outline of the minimum requirements for acceptance of papers. These cover in detail the mechanical make-up which should be followed in preparing and submitting papers for the contest.

Papers must be submitted to the Secretary for acceptance by April 1, 1953. If the Secretary finds that they meet the minimum requirements of the contest, he will forward them to the Awards Committee for review. The papers will be identified by number only. The Secretary of the Society is the only person who will maintain the key to the authors.

If any paper does not comply with such minimum requirements, the Secretary will so advise the author and discuss with him the points which are below the minimum requirements. The papers which are accepted will be forwarded to the Awards Committee for judging not later than May 1, 1953. Papers which have not met the minimum requirements by that time cannot be considered for prizes.

Papers which are accepted will be judged on originality of presentation, editorial merit and value to the engineering profession.

The papers submitted must not have been previously published in substantially the same form. No copyrighted materials shall be used unless permission has been obtained and so indicated. All manuscripts, drawings, etc., are to become the property of the Society and cannot be published without the consent of the Society.

If the papers submitted are NOT of sufficient merit to warrant the award of any or all of the prizes, the Awards Committee reserves the right to award less than the five established prizes or to postpone the competition.

The winners will be announced and the prizes presented at the annual meeting of the Society in June, 1953.

WSE Executive Secretary will furnish you with a complete set of rules and minimum requirements on request.

Home Building

(Continued from Page 24)

other the exterior finish. Between the two will be reenforcing or strength-giving materials, of the moulded plastic variety, and, if possible, a plastic stud in place of a wood member. The inner and outer surfaces will be glued to the plastic member. Experiments along this line are encouraging. Many of the present sheet materials such as the hard boards offer great promise, and if they fall short I believe that improvements in their manufacture can be expected. Experiments in floor panels along the same line are encouraging, too.

"Such a panel offers much through the medium of local assemblies. The reenforcing members can be molded at one central point in the country, shipped to various assembly plants where they would be, along with windows, doors and sheet materials, assembled into full wall sections. Such construction could be carried out in almost any country in the world. Even if certain materials had to be imported, they would form little bulk and make up only a fraction of the total cost. The world is full of raw materials for the manufacture of sheet materials needed. In fact, if necessary, these materials can be grown as a crop. Think of the bagasse that is burned or wasted each year."

Science Association to Hold Meeting

The 119th annual meeting of the American Association for the Advancement of Science is to be held in St. Louis, from December 26 to 31. Indications are that this meeting will be one of the most important the Association ever held. It will be a part of Washington University's Centenary, officially recognized as the concluding event of the Centennial of Engineering. The general theme of the convention is to be "The Contribution of Science and Mathematics to Engineering and Industry."

At the convention there are to be two general symposiums. The first, of three or four sessions, will be on Disaster Recovery. The second, of two sessions, will be on The Nation's Nutrition: from Soil to Cytoplasm.

Obituaries

Robert Knight, Life Member of the Western Society, died November 24, 1952, at the age of 82.

Mr. Knight had been a Civil Engineer, and Deputy Building Commissioner of Chicago for 35 years until his retierment 10 years ago.

Besides being a member of the Western Society of Engineers, Mr. Knight was a Past President of the Building Officials Conference of America, the Chicago Historical Society, Illinois Catholic Historical Society and the State Historical Society.

He is survived by his widow, Adeline, two daughters and a son.

Mr. Knight joined the Western Society in 1919.

G. Earl De Bourge, Estimator for A. J. Boynton and Company, died November 11, 1952.

Mr. De Bourge graduated from the Armour Institute in 1928.

He joined the Western Society of Engineers in 1926.

Charles A. Brizzolara, Works Manager for Danly Machine Specialties, died October 23, 1952. Mass was offered for him in St. Luke's Church in River Forest.

Mr. Brizzolara died in his home in River Forest. He is survived by his widow, Olivia, two daughters, a brother and a sister.

He joined the Western Society in 1928.

Joseph L. Farrelly, Architectual Engineer with the Chicago Board of Education, died August 30, 1952.

Mr. Farrelly was born in Chicago, and graduated from the Armour Institute in 1913. He became a Civil Service employee of the Board of Education at that time. He was highly esteemed as one of the Board's most valuable and genial employees.

Mr. Farrelly joined the Western Society of Engineers in 1936.

Physical, Psychological Problems to Face Space Travel

The possibility of manned rocket flights to the borders of space poses numerous problems on what would happen, physically and psychologically, to human beings traveling in the region beyond the terrestrial atmosphere. This was brought out September 9, in an address by Heinz Habor, associate physicist in the Department of Engineering, University of California, Los Angeles, at the fall meeting of the American Society of Mechanical Engineers in the Hotel Sheraton in Chicago.

While, geographically speaking, the limit of the atmosphere is located at about 600 miles above the earth's surface, he said, a new concept of the atmosphere must be found in relation to rocketry and aviation medicine.

"Functional borders between atmosphere and space" have been defined, as a result of research, as the level above the ground at which the atmosphere fails as a supporting medium. Depending on the nature of the various functions, the borders are located at different altitudes between 10 and 120 miles. In these regions of the atmosphere the conditions of conventional aviation gradually blend into those of actual space flight. For researchers in the many fields working on the complex problems of manned space flights, the term "aeropause" was coined to designate these regions, Mr. Haber explained.

At 10 miles above the earth the oxygen content of the atmosphere is so low that a person hitting this border will lose consciousness in 15 seconds. The internal pressure of the body fills the lungs with water vapor and carbon dioxde so that no additional oxygen can enter.

At 12 miles the barometric pressure of the atmosphere can no longer prevent the body fluids from boiling.

After 15 miles the atmosphere will not sustain the combustion of fuel.

At 13 to 23 miles up cosmic radiation becomes a health hazard to man. According to one estimate, an individual exposed to cosmic radiation at this point would receive a concentration equal to 6.2 x 10-12 grams radium elements per cubic centimeter. This comes very close to the amounts of radioactive energies considered harmful to tissue.

Ultra-violet solar radiation presents another hazard when man reaches the 22 to 28-mile altitudes, causing erythema of the skin and conjuctivitis. The bulk of atmospheric ozone, a more effective absorber of ultra-violet radiation than all metals, is found in the layer between nine and 25 miles up. Although small in amount, it provides an effective blanket against those parts of ultraviolet radiation affecting the skin and eyes. It has been estimated, according to Mr. Habor, that erythema of the skin within and above the ozone layer is produced 10 to 50 times as fast as at sea level. Protection against ultra-violet radiation, therefore, is mandatory at altitudes in excess of 15 miles. Fortunately, window materials capable of absorbing these kinds of radiation are available, he said, adding that the presence of ozone above the 8-mile level can result in toxic concentrations of this gas in the cabin air, if the pressurization of the cabin is maintained by compressing ambient air. Fortunately, ozone is easily intercepted by means of simple filters.

At 50 to 60 miles the atmosphere ceases to supply aerodynamic lift and drag, or, in other words, at this point the crew of a big flying rocket craft will be transposed into a state of weightlessness. Experiments have shown that this state creates only slight disturbances in circulation and breathing. But a pronounced effect can be expected on man's ability, for instance, to walk or move in a given direction (since there is no force of gravity holding him down), or to pick up things or coordinate body movements with his sense of touch. Optical illusions may occur too. There is as yet very little definite knowledge of the psycho-physical consequences of weightlessness which offer a challenge to space-medical research, Mr. Haber said.

At 60 to 90 miles the absence of diffuse daylight provided by the atmosphere poses a visual problem. The brightness of the sky depends on a number of factors, including the zenith distance of the sun, the reflectivity of the earth, and altitude. At heights over 85 miles the light of sky approaches that of a moonless night at sea level. From there on the black of space is complete. Looking down from a high-flying craft the sunlit ground and clouds below are brighter, in contrast, than the sky above. At a height of 20 miles, sunlit objects as small as the disk of the moon appear too bright for comfort, if their reflectance is larger than 10 per cent.

Describing the effect on human eyes, he observed, "Far more discomfortable brightness contrasts will be encountered inside the cabin of a high flying ship where sunlit patches will be seen adjacent to deep shadows. Owing to the small illumination of the waning light of the sky, the interior of a cabin will be rather dark. Reading of instruments will be impossible unless they are illuminated artificially. These conditions will un-

(Continued on Page 28)

(Continued from Page 27)

doubtedly cause visual discomfort, fatigue, or even disabling glare. The use of light-diffusing panels covering a certain section of the window area have been suggested. In this way, the interior of the ship would be shielded against direct sunlight. At the same time, such a device would provide a sufficient amount of comfortably diffuse illumination from the panel that substitutes for the loss of diffuse illumination normally afforded by the light of the sky.

"The hazards arising from possible impacts with meteors is of particular space-medical interest. Even moderately large meteors can easily puncture the hull of a high-flying ship—an event which would result in a very rapid explosive decompression of the crew. At altitudes accessible to man with present-day means, no hazard from meteors exists, since most meteors are vaporized and annihilated at great altitudes. The great majority of meteors ranging between fine meteoric dust and particles weighing a gram or more, are absorbed before reaching the 60-mile level. Above 90 miles of altitude, however, a ship would run the same risk of being hit by meteors as in interplanetary space, except for the protection afforded by the shielding bulk of the earth," he said.

One of the most intriguing problems of modern aviation is the generation of an envelope of hot air around a fast flying aircraft, owing to aerodynamic or friction heating, he said. It has been found that in a range between 80 and 100 miles of altitude, air drag and skin heating of a satellite vehicle for a velocity of five miles per second will become negligible. But temperature problems of rocket flight persist even at great altitudes. Beyond the border of thermal interaction between atmosphere and craft, there is the heat caused by radiation between the exterior of the craft and the sun, earth and cosmos. It has been found that gleaming white materials such as magnesium oxide can serve as surface coatings, if a manned craft is exposed to the field of thermal radiation in space.

From the standpoint of space-medicine temperature presents one other problem: that of human survival if the cooling system fails. It has been found that at 185 degree Fahrenheit a person would collapse in 60 minutes. At 500 degrees it would take three minutes.

The 120-mile level can be considered the mechanical border of space, where air drag vanishes completely and a permanent satellite orbit would be possible. Above this level the state of weightlessness can be maintained for any length of time.

Here there are only three factors of terrestial origin that make the environment of the craft different from that found at any other point of interplanetary space, he said. They are: the bulk of the earth which shields off half the number of meteors and cosmic ray particles; the magnetic field of the earth which deflects cosmic ray particles below a certain magnetic rigidity, if they approach the earth in or near the equatorial plane; and the solar radiation reflected by the earth and its atmosphere, and the infrared radiation emitted by the earth proper.

Canadian Official Issues Message

Louis St. Laurent, Prime Minister of Canada, issued a special message commemorating the Centennial of Engineering held in Chicago this summer as significant of the contributions made by the engineering profession to the spectacular development of the nations of the North American continent.

Addressing his commendation to Major Lenox R. Lohr, the Centennial's president, the Canadian Prime Minister stated,

"On this significant occasion I am reminded of the words of a former Governor General of Canada, Lord Tweedsmuir, who, speaking at the semi-centennial of the Engineering Institute of Canada in 1937, described Canada's engineers as "the pathfinders, the roadmakers, the Cyclopean architects of a land whose horizons are not limited, and whose future no man can assess."

"The United States and Canada owe much to the members of the engineering profession. They have made a notable contribution to our growth and expansion as nations in the past, and I feel sure that in the future development of our two countries they will play an ever-increasing role.

Engineering Societies Personnel Service, Inc.

New York Chicago Detroit San Francisco

84 East Randolph St., Chicago 1, Ill., ST ate 2-2748

These items are from information furnished by the Engineering Societies Personnel Service, Inc., Chicago. This SERVICE, operated on a co-operative, non-profit basis, is sponsored by the Western Society of Engineers and the national societies of Civil, Electrical, Mechanical and Mining and Metallurgical Engineers. Apply to ESPS, Chicago and the key number indicated. Prepared ENGINEERS AVAILABLE advertisements limited to 40 words, with typed resume attached may be submitted to ESPS Chicago by members of Western Society of Engineers at no charge.

OVER THE MANAGER'S DESK

Christmas and New Years! This is the time of year when we all like to relax and think of friends. We, the E.S.P.S., also like our friends who have given us such splendid cooperation throughout the past year. Whether you are an employer or an individual applicant, we need you and we appreciate the opportunity to be of service to you.

The writer and the Chicago Staff of E.S.P.S. sincerely hope that you and yours have the most Merry Christmas you have ever had, followed by the happiest, brightest, healthiest, and most prosperous New Year of your entire career. Good luck and good wishes!

B.H.A.

POSITIONS AVAILABLE

R-9440(a) SHEET METAL or MACHINERY DRAFTSMEN-DESIGNERS. (3). Duties: detail and some design of sheet metal or machinery parts. Quali: some sheet metal or machinery drafting exper. necessary. Salary: $250-$375 per mo. Loc: Chicago.

R-9440(b) TOOL DESIGNER. Duties: design tools, dies, jigs and fixtures. Qual: several years similar exp. Salary: $375 per mo. plus overtime compensation. Location: Chicago.

T-9439 GENERAL SUPERINTENDENT Col. preferred. Age: 35-50. Ten years exp. in open pit iron ore mining, Knowledge of iron ore beneficiation. Duties: active in the field, supervision and coordination of the activities of superintendents and department heads. For an ore mining company. Salary: $600-$900. Car required. Location: Minnesota.

R-9436 STAFF ENGINEER. Age. 30-55. 5 plus years experience in management controls. Knowledge of cost accounting or time study. Duties: staff engineer for consulting industrial engineering firm. Salary $600 per mo. Considerable traveling. Employer may negotiate fee. Loc: Headquarters: Chicago.

R-9435 CHIEF INDUSTRIAL ENGINEER. College Grad M.E. Age: 35-50. Ten yrs. exp. in manufacturing controls, operating standards, methods analysis, work simplification, time and motion studies, cost studies, training, incentive programs. Know: of light metal manufacturing. Duties: chief industrial engineer to supervise & administer industrial engineering functions on a plant modernization program. Comp. Mfrs. fasteners, screw-nuts-bolts. Salary: $10,000-$15,000 plus bonus based on profits. Location: Chicago.

T-9434(a) DEVELOPMENT ENGINEERS (2) ME. Training. Age: 28 to 40. 3-5 yrs. exp. mechanical development work, preferably along hydraulic lines. Duties: layout and design for portable hydraulically operated equipment. Housing available. Good opportunity—rapidly growing manufacturer. Salary: $5000 plus 1 yr. Employer will pay fee. Loc.: Ill.

T-9434(b) DRAFTSMEN. Mechanical (4). Duties: all board work on portable hydraulic equipment. Housing available. Good opportunity with rapidly expanding manufacturer. Salary $4000 plus. Employer will pay fee. Location: Illinois.

R-9432 DRAFTSMAN. Age: 25-35. Two years plus exp. in drafting of special hydraulics, piping of valves. Knowledge of high pressure cartridge helpful. Duties: drafting special mechanical and hydraulic devices. For a manufacturer. Salary: $350-$400 per month. Employer will negotiate fee. Location: Chicago.

R-9431 JUNIOR INDUSTRIAL ENGINEER IE or ME. Recent Graduate or better. Duties: general industrial engineering such as time study methods, and job simplification. For a manufacturer of paints. Salary: Up to $375 per month. Location: Chicago.

T-9427(c) DRAFTSMAN. 1 yr. plus exp. in detailing machinery or production machinery equipment. Duties: detail special machinery. For a manufacturer of machinery. Salary: $1.75 to $2.25 per hour. Employer will negotiate fee. Location: Illinois.

If placed in a position as a result of an Engineers Available or Position Available advertisement, applicants agree to pay the established placement fee. These rates are available on request and are sufficient to maintain an effective non-profit personnel service. A weekly bulletin of positions open is available to subscribers. Apply ESPS Chicago.

ENGINEERS AVAILABLE

CHEMIST. Chem. 29. Two yrs. chemist to formulate or obtain coating for paper conversion to food packaging materials. Midwest $4800 516MW.

MET. ENGR. Met. Eng. 29. Thirteen mos. Ass't Metallurgist, in solutions of problems involving forging, machining, casting and some welding of low alloy, plain carbon and manganese steel. $4300 Chicago 517 MW.

DEVELOPMENT ENG. 28. Two and one half yrs. development of regulators, torches and old machines for new applications. Two yrs. testing thermical power plant devices. Midwest $6000 518 MW.

CHIEF ENGR. ME 53. Five yrs. consulting engr. general consulting services to various industrial plants. Fifteen yrs. Admn. Engr., supervision of refrigeration & motive power operations, plant layout, maintenance and installation. Midwest $7000 519 MW.

PROD. MGR. IE 30. Four yrs. asst. to V.P. Prepare rotary printing specifications: cost estimates and summaries of engineering projects, schedule and expedite work. Fifteen mos. job evaluation of hourly factory jobs. $5000 Chicago 520 MW.

FACTORY MANAGER ME 33. Seven yrs. assist. Chief Engr. of design & development of leather & synthetic rubber products. Four yrs. supervision and design of special machines. Chicago $12,500 521 MW.

RESIDENT ENG. CE 36. Five yrs. charge design of new plants, major projects. Seven mos. supervising construction of a factory. $9600 Midwest 522 MW.

ASST. TO CHIEF ENGR. ME 29. One yr. Tool and Methods Engr., on oil pumps. Six mos. coordinating tool forming, punch press dept., and tool room. Three yrs. process engineering telephone equipment. $7200 Midwest 523 MW.

FIELD ENGR. CE 27. Four and one half yrs. superivising research projects in field and prepare reports, also some laboratory projects. $6000 Southwest 524 MW.

Reviews of Technical Books

Available at WSE Headquarters

Hydrology

Hydrology, by C. O. Wisler and E. F. Barter, John Wiley & Sons, Inc., New York 16, N. Y. First Edition, 1949. 419 pages. $6.00.

This book was designed for the general practicing engineer, forester and agriculturist, as well as for the student who is looking for the basic principles of hydrology.

It provides information which can be used in the determination of the maximum flood flow that can be expected every few years, the maximum flow that will occur with rare frequency such as once in a thousand years, the ground water yield of a well or of any given area, and similar problems.

The hydrograph, precipitation, infiltration, ground water, floods, and stream flow records receive expert treatment.

The subject is logically developed and made easily accessible by the liberal index.

H.P.W., W.S.E.

Metallurgy

Metalurgy for Engineers by John Wulff, Howard F. Taylor, and Amos J. Shaler, John Wiley & Sons, Inc., New York 16, N.Y. First Edition, 1952. 624 pages. $6.75.

This book was written primarily as a textbook for engineering students, but may be used to advantage by the practicing engineer as a "refresher course" and to acquaint him with concepts developed in recent years. It covers the field of casting, welding, and working and should help the reader to acquire an adequate understanding of metals so that he may intelligently select and use them.

The book is logically developed and is written from the engineering rather than the shop viewpoint. The first half explains the concepts and principles that underlie metal processing from the ingot to the finished article. The second half deals with the processes themselves.

Each chapter ends in a summary, a list of definitions, a group of questions, and numerous references.

An appendix covering metal and alloy properties, and process costs completes the work.

H.P.W., W.S.E.

Graphics

Engineering Graphics by John T. Rule and Earle F. Watts, McGraw-Hill Book Company, New York 18, N. Y. First Edition, 1951. 300 pages. $3.75.

Here is a distinctly new approach to the study of engineering drawing that considers the subject from both the analytical and representational viewpoints.

In the past, the full power of graphics has scarcely been suggested to the student. This book contrasts the graphical solution of engineering problems with the algebraic. It attempts to show that a graphical solution is quicker than its algebraic counterpart, less susceptible of accidental error, more illuminating with respect to the natural process involved, and more suggestive and fruitful for predictive purposes.

The aim of the part of the text dealing with representational graphics is not to train a practical draftsman in detail but to give the engineer a suitable knowledge of the principles with which the draftsman works.

Work in certain chapters can be keyed to other engineering courses; the material on conic sections with analytical geometry, sections on derived curves with calculus, and emperical curves with physics and chemistry.

A wide range of problems is included in the text, and these are worked out in detail in the manner in which they should be mastered.

This book should be received with enthusiasm by the interested student.

H.P.W., W.S.E.

Electronics

Fundamentals of Electronics and Control, by Milton G. Young and Harry S. Bueche, Harper & Brothers, New York 16, N. Y. First Edition, 1952. 525 pages. $6.00.

This up-to-date book is a thorough and quite complete text for use in the first course in electronics. This applies not only for an electrical engineering program, but also for industrial and mechanical engineering programs. The text was written with the objective in mind of giving to students in the above fields a comprehensive understanding of the basic operations of electronic tubes and other equipment used in the electronic field.

The inclusion of several pages on the transitor is an indication of the timeliness of *Fundamentals of Electronics and Control*. It is well illustrated and has a great number of graphs, schematic diagrams, and formulas. Besides the usual index and table of contents, this book has 13 appendices covering such subjects as average plate characteristics of various radio tubes, a Color Code Chart for Resistors and Condensers, graphical symbols for Electron Tubes, and magnetization curves for 4 per cent silicon steel.

H.K.E.

High Fidelity

High Fidelity Simplified, by Harold D. Weiler, John F. Rider Publisher, Inc., New York 13, N. Y. First Edition, 1952. 208 pages. $2.50.

Due to the growing cultural maturity of the United States, more and more engineers and others are becoming interested in fine music and the allied arts. From this source, interest in the high fidelity transmission and reproduction of sound also is growing. High fidelity, as used in the book, means superior sound reproduction, and this book covers the subject in a very satisfactory manner. Not highly technical, the novice who wishes to obtain a background in the subject can do so from this book. But also, the engineer who works in the field will find much of interest in the book, and will see even better how the various agents of high fidelity, such as Long Playing records, FM radio, and good loudspeakers are related to each other.

To make the book of greater value, there are 104 illustrations, the usual index, and a list of high fidelity component manufacturers.

H.K.E.

So that the Society may serve *YOU* better,

Be sure to keep it informed of any changes in your status

Do We Have:

Your Position?

Your Firm Name?

Your Firm Address?

Your Home Address?

Your Phone Numbers?

To make sure we have you listed correctly,

MAIL THIS FORM TO THE WESTERN SOCIETY OF ENGINEERS
84 E. Randolph St., Chicago 1, Ill.

Name: ....

Position: ....

Firm: ....

Firm Address: ....

Home Address: ....

Home Phone: .... Business Phone: ....

Index of Advertisers

NO OTHER GIFT DOES SO MUCH FOR SO MANY!

COMMUNITY FUND